ORIGINAL ARTICLE

ADVANTAGES OF CONE BEAM COMPUTED TOMOGRAPHY IN DIAGNOSIS ASSESSMENT OF PERIAPICAL LESIONS OF ENDODONTIC ORIGIN

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ABSTRACT

Purpose. The aim of the present study was to assess the accuracy of Cone-Beam Computed Tomography in contrast with traditional intraoral periapical radiography used in endodontic treatments.

Material and methods. Statistical analysis was performed on 10 radiographs and CBCT's of 10 patients using the periapical index (RxPAI) and the Cone-Beam Computed Tomography periapical index (CBCTPAI).

Results. CBCTPAI ranged from 2 to 5 with variables added to some of the cases and the RxPAI from 1 to 3. The maximum diameters of RxPAI ranged between 1,69-3,99 mm and CBCTPAI from 0,64-8,75 mm and the perimeters and area were in average 30 mm, and 35 mm2 respectively.

Conclusions. The study displays that quite a few critical radiological signs gathered by using CBCT are not always visible in periapical radiographs. Moreover, CBCT could be applied to clarify diagnostic questions, essential to a much needed control and treatment of the endodontic lesions.

Keywords: cone beam computed tomography, periapical radiography, periapical index, periapical lesions.

INTRODUCTION

Radiology is important to endodontics for diagnostic purposes, clinical planning and execution, and therapy effectiveness assessment. Until a few years ago, periapical radiography (PR) and orthopantomography were the main radiographic investigations used in the endodontic treatment. [1]. One of the most common reasons for recommending imaging investigations in a daily dental practice is represented by periapical inflammatory lesions. In detecting osseous anomalies in the jawbones, imaging plays a key role. The first and only indicator of an asymptomatic apical periodontitis in some patients may be a periapical lesion visualized on the periapical radiography (PR). In detectability, multiple variables play a key role [2]. Effective accurate assessment of the periapical conditions is not only important for diagnosis but also for care and follow-up. Significant information is needed for care planning purposes. The extent of the lesion, the number of the roots and of the root canals in the affected tooth, the careful involvement of the roots by the lesion and the link between the lesions on separate roots of the same tooth should be known. Knowledge of the relationship between root apices and between the lesion and neighboring anatomic characteristics are vital in cases where periapical surgery is indicated [3].

In 2000, Cone-Beam Computed Tomography (CBCT) was introduced, which allows the three-dimensional imaging of the hard tissues in jaw volumes and can serve as a powerful tool for endodontic diagnosis, for scheduling and follow-up treatments. At the same time, in each situation, the decision to subject a person to a CBCT examination must be taken to assess the risk/benefit ratio, which is dictated by the need for optimum control of endodontic care [4].

The aim of the present study was to assess the accuracy of CBCT in contrast with traditional intraoral PRs used in endodontic treatments.

MATERIAL AND METHODS

Statistical analysis was performed on ten digital periapical radiographies (PR) and CBCT's of ten patients that were obtained from the Department of Radiology, Faculty of Dentistry, "Victor Babes" University of Medicine and Pharmacy, Timișoara, after the inform consent of the patients. One experienced operator has analyzed each tooth and the surrounding periapical structures, highlighting all the images with possible endodontic relevance. For the CBCT images, the radiolucency should be visible at least in two image plans (0.5 mm thickness) for taking into consideration.

The CBCT scans have been compared to the corresponding intraoral control PRs. For each detected periapical lesion, the periapical lesions of endodontic origin were evaluated and assessed by using two of the following indexes: the Periapical Index (RxPAI) [5] and the Cone-Beam Computed Tomography Periapical

Index (CBCTPAI) [6].

On PRs the score range is given according to the size of the apical periodontitis (AP) and it is between 1 and 3 as follows, depending on the size of the lesion in millimeters [5]:

1 < 3 mm

2 > 3 mm and > 5mm

3 >5 mm

On CBCT the size of the processes that suggest the presence of periapical lesions was measured using OnDemand3D software in all three anatomic planes: axial, sagittal and coronal. CBCTPAI is determined by the largest size of the lesion, and the score range is between 0 and 5 as follows [6]:

0 - Intact, unaltered periapical bone structures

1 - Diameter of periapical radiolucency 0.5-1 mm

2 - Diameter of periapical radiolucency 1-2 mm

3 - Diameter of periapical radiolucency 2-4 mm

4 - Diameter of the periapical radiolucency 4-8 mm

5 - Diameter of the periapical radiolucency > 8 mm

In addition to these 6 scores were added two variables that can be assigned concurrently with the scores if the conditions are met: variable "E" – expansion of the cortical bone in the periapical area and variable "D" - destruction of cortical bone in the periapical area [6].

The results of these studies were included in a primary statistical analysis using the Microsoft Excel program, which aimed to compare, both by boxplot graphical representation of the dimensions of the periapical processes on CBCT compared to RX, as well as the PAI scores.

RESULTS

The results in our study show a prevalence rate on periapical radiographs of 47%, with 11% partial observance, while in 42% of the cases no periapical lesion could be observed. Using CBCT, in 82% of the case studies the lesions were detected. CBCT periapical index ranged from 2 to 5 with variables added to some of the cases and the RxPAI from 1 to 3, (Table 1). The maximum diameters of Rx periapical index ranged between 1,69-3,99 mm and CBCT periapical index from 0,64-8,75 mm and the perimeters and areas were in average 30 mm, and 35 mm^2 respectively.

DISCUSSIONS

CBCT scanning, which allows the 3-dimesional (3D) imaging of the teeth and the surrounding structures, can overcome the limitations of intraoral periapical radiography, which produce only 2-dimensional images (2D) eliminating the overlapping of the anatomical structures (anatomical noise) [7,8]. Several studies concluded that more defects were detected on CBCT than on PRs and on average, the periapical bone defect measured on periapical radiographs was approximately 10% smaller than on CBCT images [4,9] which is consistent with our findings regarding the difference between RxPAI and CBCTPAI. Also, Patel S. in a review regarding CBCT in endodontic imaging concluded that the true size, location and extent of the periapical lesion can be appreciated [8], which is not always possible using PRs. Another study that evaluated molars with no pre-operative apical radiolucency revealed a fourteenfold higher failure rate when assessed using CBCT (17.6%) compared with PRs (1.3%) [9]. These findings are also sustained by other human in vivo experiments that concluded that CBCT is significantly more sensitive than PRs in detection of apical periodontitis [10], the periapical lesions can be identified earlier on CBCT scans than on conventional radiographs [11,12] and another study found that CBCT detected 62% more periapical lesions than conventional radiographs [13]. Similar data was reported by subsequent studies [14, 15] regarding the prevalence of periapical lesions on CBCT and PRs and are in accordance with the results of the present study.

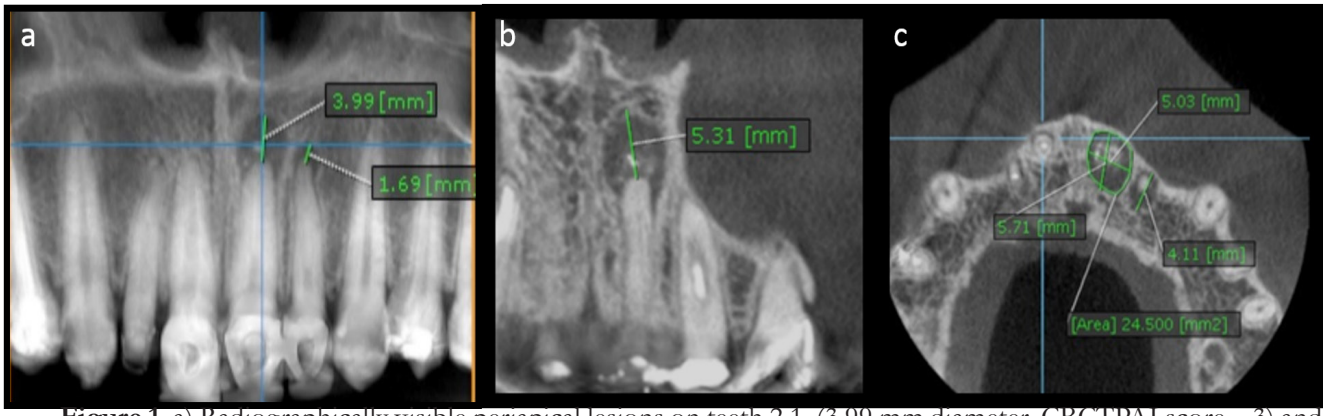

Figure 1. a) Radiographically visible periapical lesions on teeth 2.1. (3,99 mm diameter, CBCTPAI score – 3) and 2.2. (1,69 mm diameter, CBCTPAI score – 2). b) Coronal section shows that the diameter of the lesion has increased to 5.31 mm and subsequently the CBCTPAI score is 4. c) The axial section shows a biggest area of periapical lesion and has been determined as being 24.5 mm2.

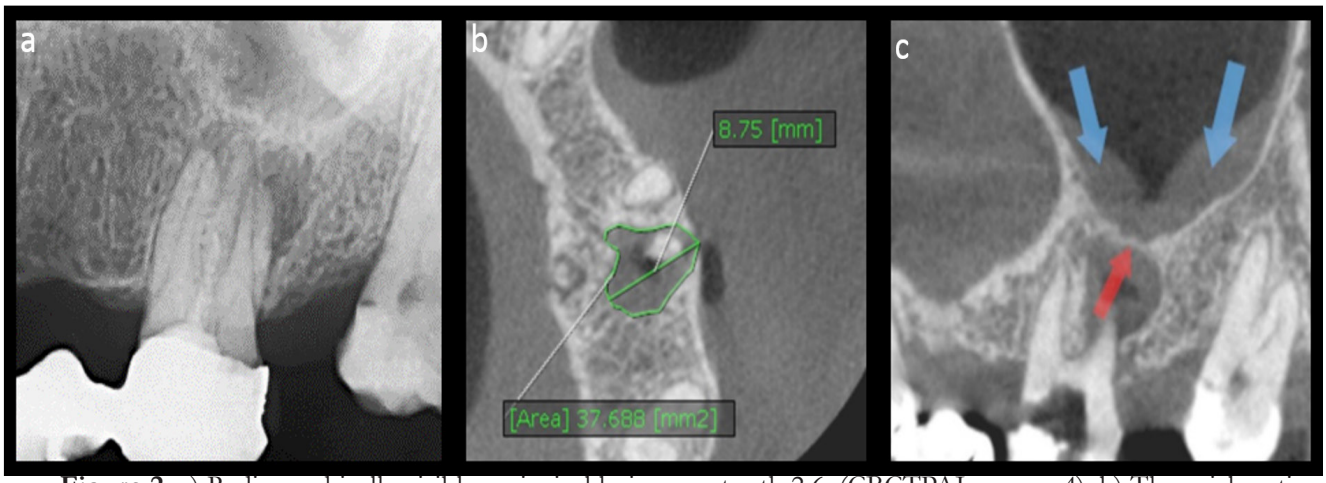

Figure 2. a) Radiographically visible periapical lesions on tooth 2.6. (CBCTPAI score – 4). b) The axial section shows a maximum periapical lesion diameter of 8,75 mm and a calculated area of 37,688 mm2. Also, the vestibular cortical bone perforation can be observed (red arrow), (CBCTPAI score – 5 with variable "D"). c) On sagittal section can be observed the closeness of the lesion to the maxillary sinus (red arrow) and the consequent inflammation of the Schneiderian membrane (blue arrows).

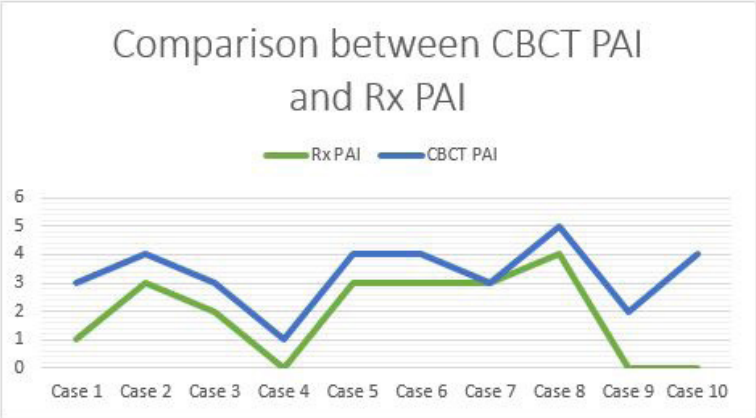

Table 1.
Comparison between CBCTPAI and RxPAI.

CONCLUSIONS

Within the limitations of this study, it could be concluded that periapical lesion detection was noticeably higher by using CBCT than with periapical radiography. CBCTPAI offers an accurate diagnostic method, with greater specificity than RxPAI, which can diminish the incidence of false-negative diagnosis. The study displays that quite a few critical radiological signs gathered by using CBCT are not always visible in periapical radiographs. Moreover, CBCT could be applied to clarify diagnostic questions, essential to a much needed control and treatment planning of the endodontic lesions.

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